



Fossil decapod crustaceans from the Lower Cretaceous, Glen Rose Limestone of Central Texas

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Abstract. The Lower Albian carbonate rocks of the Glen Rose Limestone of Central Texas contain a diverse decapod fauna dominated by *Protocallianassa* species with 10 other taxa represented by fewer specimens. The fauna consists of *Protocallianassa* species, *P. kloffi*, new species, *Pagurus banderensis* Rathbun 1935, *Roemerus robustus*, new genus and species, *Palaeodromites naglei*, new species, *Diaulax roddai*, new species, *Hillius youngi*, new genus and species, *Dioratiopus scotti*, new species, *Pseudonecrocarcinus stenzeli*, new species, *Prehepatus hodgesi*, new species, and *Torynomma? densus*, new species.

INTRODUCTION

The remains of fossil decapods have been among the most rarely reported fossils in the Glen Rose Limestone of Central Texas. Rathbun (1935:35) described *Pagurus banderensis* from a single fragmental specimen. Stenzel (1945:435) revised that description on the basis of several additional specimens and mentioned that other decapods were associated with the *P. banderensis* remains described by him. "Among the other chelae found by Mr. Watkins at the same locality there are some which obviously can have nothing to do with *Pagurus*, because they belong to other well-established and unrelated genera such as *Callianassa*" (Stenzel 1945:437).

The fauna described here is important because it testifies to the presence, abundance, and diversity of the decapod fauna of the Glen Rose Limestone. This fauna adds to our knowledge of the Early Cretaceous decapod fauna of North America. A diverse fauna of Late Albian age has been described by Rathbun (1935).

THE GLEN ROSE LIMESTONE

The Glen Rose Limestone is composed of beds of limestone that are resistant to weathering alternating with less resistant marls, giving rise to a characteristic stair-step topography (Fig. 1). The presence of mud cracks, bored bedding planes, bedding planes with encrusting oysters, algal mat laminations, ripple marks, dinosaur trailways, and plant debris is evidence for supratidal, intertidal, or shallow subtidal conditions. Beds of lime muds containing echinoids, miliolid foraminifera, infaunal pelecypods, corals and numerous gastropods imply marine conditions prevailed at times. The interbedding of these sediments points to a depositional system of shallow marine lagoons with numerous small islands or rapidly prograding supratidal areas in protected lagoons behind a reef-like barrier (Winter 1962, Hendricks and Wilson 1967:5, Stricklin et al. 1971, Young 1972:1).

The Glen Rose Limestone of Central Texas contains a scant ammonoid fauna which allows correlation with the European section (Young 1972:11, 1974:179). The Glen Rose Limestone is divided into upper and lower members by a bed (or zone of beds) containing numerous steinkerns of the bivalve *Corbula* (Stricklin et al. 1971:23).

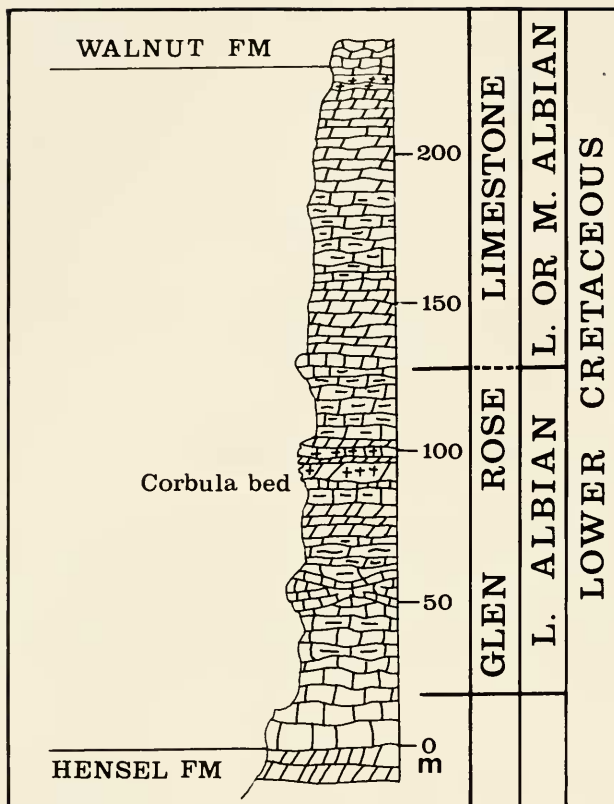


FIGURE 1. Lithostratigraphy and biostratigraphy of the Glen Rose Limestone (after Young 1974).

The “*Corbula*” bed is used in this study as a stratigraphic marker to locate the stratigraphic position of each collection. All of the Glen Rose Limestone below the *Corbula* bed and to a level of about 41 m (135 ft) above it are considered to be Early Albian by Young (1974:176). This includes all of the specimens described in this study.

LOCALITIES

Most specimens of decapods have been collected from 3 localities (Fig. 2). The specimens are from several collections: (GAB = Gale A. Bishop; SDSNH = San Diego Natural History Museum; WSA = W. S. Adkins; UT = University of Texas [Austin]).

The Nagle Locality (GAB 21).—This exposure was extensively collected by J. S. Nagle during the early 1960s. It is situated at the junction of Highways 290 and 281, about 9.7 km (6 mi) south of Johnson City, Blanco Co., Texas (Fig. 3).

Decapods occur throughout about 9 m (30 ft) of Glen Rose Limestone but are more abundant in an interval just below a *Corbula* bed and in a biomicrite about 7.6 m (25 ft) above the *Corbula* bed (Fig. 4).

Interesting assemblages of microscopic claws and dactyli were recovered from samples taken at points indicated in the measured section (Fig. 4). The microscopic decapod material is particularly abundant in the *Salenia texana* marl.

The associated fauna consists of numerous steinkerns of bivalves and gastropods.

Boerne-Sisterdale Locality (GAB 25).—This exposure is a road cut on Texas Farm Road 1376 at the top of a hill (Fig. 5) 12 km (7.5 mi) north of Boerne, Kendall Co., Texas. Approximately 9 m (30 ft) of Glen Rose Limestone is exposed in the road cut (Fig. 6). The road cut is about 37 m (120 ft) above exposures of the *Corbula* bed at the Hodges Range Section (GAB 26) 1.6 km (1 mi) to the northwest, and probably

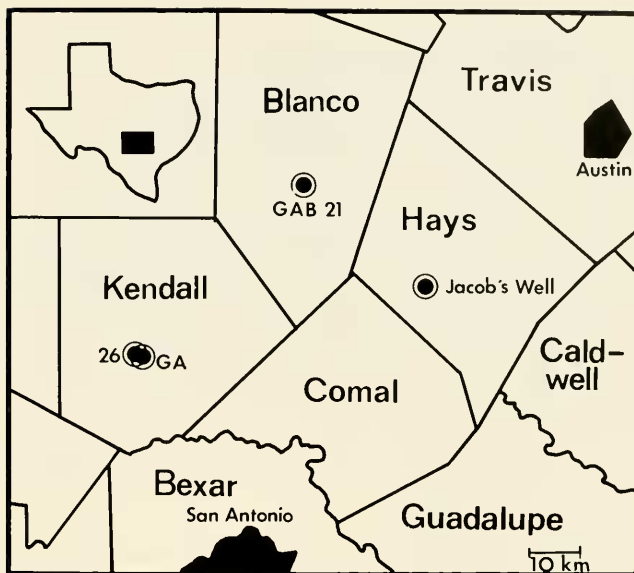


FIGURE 2. Index map of major collecting localities in Central Texas.

near the top of the fourth open shelf unit of Young (1974:177). Numerous remains of decapods were collected from a biomicrite near the bottom of the road cut (at arrow in Fig. 6).

Decapod remains occur throughout an interval 3 m (10 ft) in thickness but are most abundant in a 46 cm (18 in) bed of fossiliferous biomicrite. The specimens weather out of the platy marl and accumulate on the ledge formed by the underlying resistant bed.

The entire fauna has not been investigated in detail but numerous specimens of *Homomya* are present and preserved in living position. Other elements of the fauna include numerous pelecypods, gastropods, and masses of serpulid worm tubes.

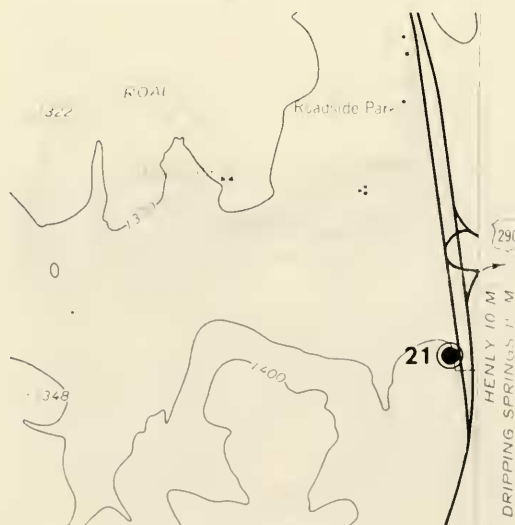


FIGURE 3. Topographic map of Nagle locality (GAB 21) 9.7 km (6 mi.) south of Johnson City at junction of U.S. Highways 290 and 281, Blanco Co., Texas. U.S.G.S. Monument Hill Quadrangle, scale 1:24 000, contour interval 20 ft (6.1 m).

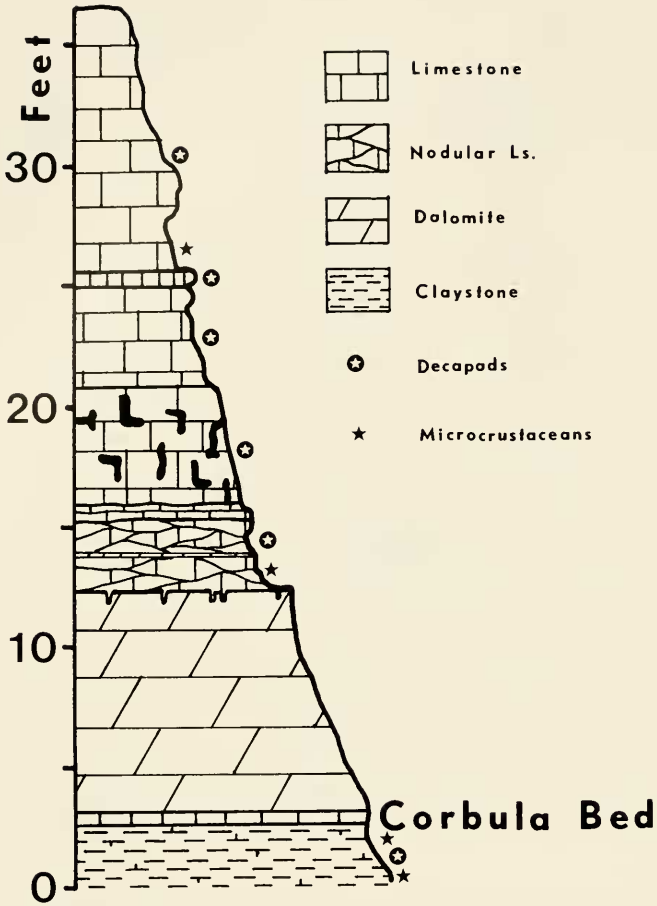


FIGURE 4. Measured section in Glen Rose Limestone at Nagle locality (GAB 21).



FIGURE 5. Topographic map of Boerne-Sisterdale (GAB 25) and Hodges Range (GAB 26) localities, 12.9 km (8 mi) north of Boerne on Farm Road 1376, Kendall Co., Texas. U.S.G.S. Sisterdale Quadrangle Scale 1:24 000, contour interval 20 ft (6.1 m).

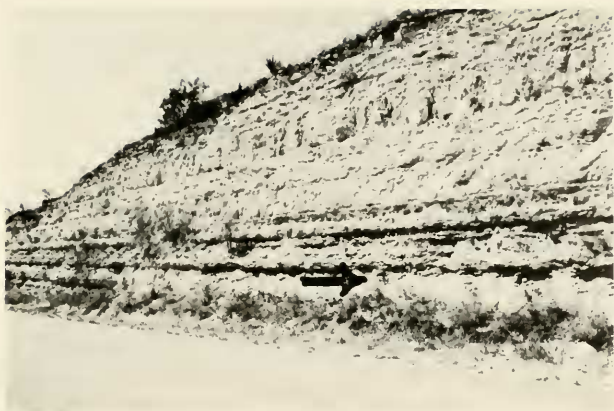


FIGURE 6. Photograph of Boerne-Sisterdale outcrop (GAB 25), decapod interval marked by arrow. Vertical scale of foreground approximately 1 cm = 2 m (1" = 17').

The Hodges Range Locality (GAB 26).—The Hodges Ranch Locality (Fig. 5) is situated on the third tributary of Wasp Creek west of Texas Farm Road 1376 about 12.9 km (8 mi) north of Boerne, Kendall Co., Texas. Specimens were collected from a soft marl that contained *Salenia texana* just below a *Corbula* bed (Fig. 1). The locality also produced numerous sea urchins and some crinoids.

The outcrop is a semi-barren gentle slope (Fig. 7) just above a small creek. The surface is covered by great numbers of fossils, especially the heart urchin *Enallaster obliquatus*. Other faunal elements include oysters, gastropods, and bivalves.

The decapod part of the fauna from this locality is almost exclusively dominated by claws of the hermit crab, *Pagurus banderensis*. A collection of gastropod steinkerns was made to examine the possibility of preserved pagurids within the lithified mud of the steinkerns. No evidence of decapod exoskeleton was observed in the steinkerns. In fact, the steinkerns were packed with numerous shells and shell fragments mixed with carbonate mud. This suggests a fair amount of washing by currents or bioturbation after the shells were last occupied (by hermit crabs?) which would destroy evidence of any such occupation.

Other localities from which Glen Rose decapods have been collected are listed below:

1. Bandera-Pipe Creek Road (Texas Highway 16) 1.6 km (1 mi) east of Bandera, Bandera Co., Texas; *Salenia texana* zone. Rathbun 1935:39.



FIGURE 7. Photograph of Hodges Range locality (GAB 26). Collecting bag in center 38 cm (15 in.) high.

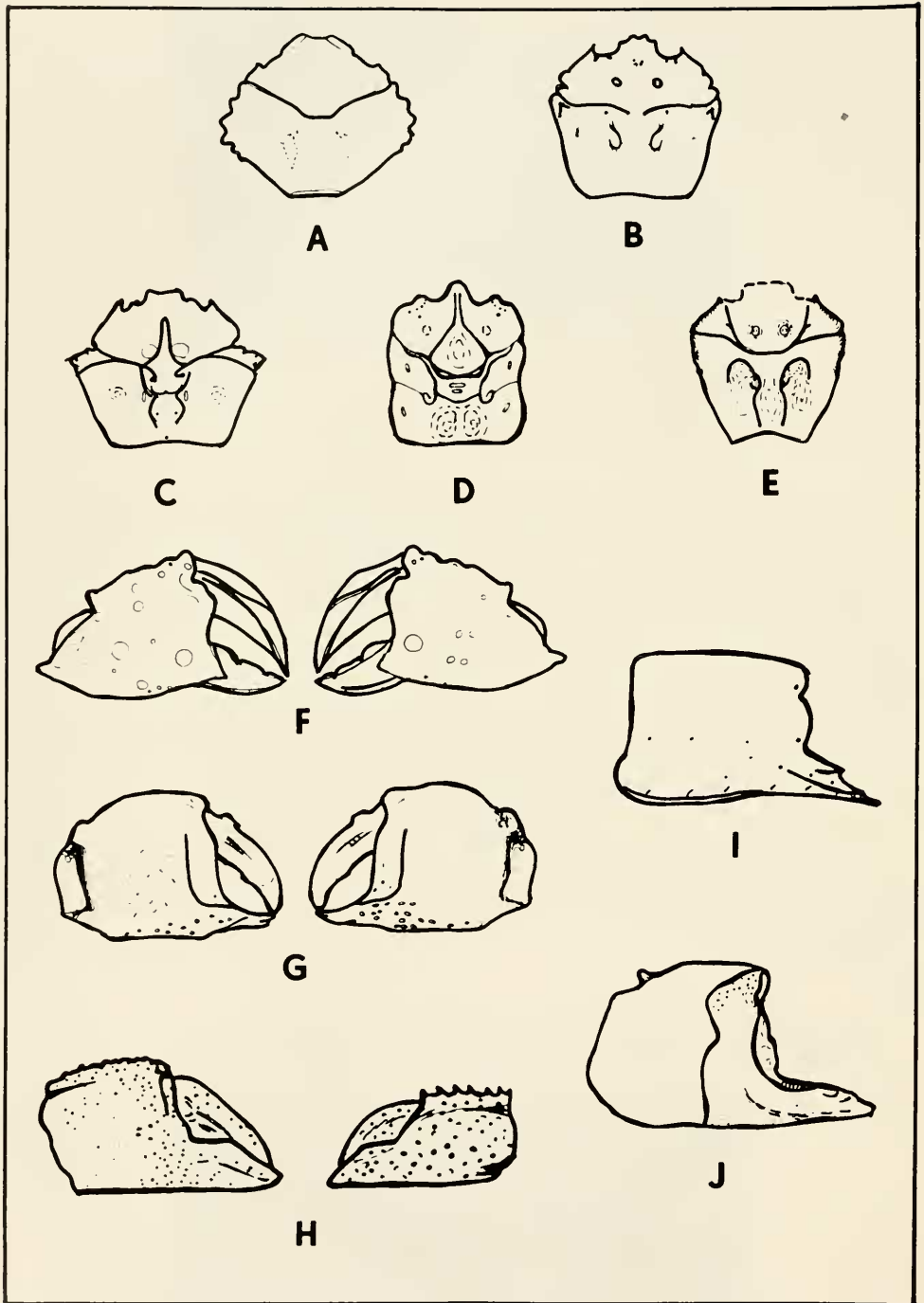


FIGURE 8. Line drawings of decapods from the Glen Rose Limestone, Central Texas. A, *Palaeodromites naglei* Bishop; B, *Pseudonecrocarcinus stenzeli* Bishop; C, *Hillius youngi* Bishop; D, *Dioratiopus scotti* Bishop; E, *Diaulax roddai* Bishop; F, *Prehepatus hodgesi* Bishop; G, *Roemerus robustus* Bishop; H, *Pagurus banderensis* Rathbun 1935; I, *Protocallianassa klofi* Bishop; J, *Torynomma? densus* Bishop.

2. Bandera-Pipe Creek Road (Texas Highway 16) 3.2 km (2 mi) east of Bandera; *Salenia texana* zone. Stenzel 1945:437.
3. "0.15 mile [0.24 km] south of state Highway No. 29 (Burnet-Austin road) and 0.07 mile [0.11 km] east of the Southern Pacific Railroad track 1.42 miles [2.27

TABLE 1. Tabulation of decapod collected from the Glen Rose Limestone.

	GAB-21	GAB-25	GAB-26	Other	Total
<i>Protocallianassa</i> sp. ^a	52	750	0	Yes ^b	802+
<i>P. klofti</i>	1	14	0	0	15
<i>Pagurus banderensis</i>	1	12	10	7	30
<i>Roemerus robustus</i>	0	2	1	1	4
<i>Palaeodromites naglei</i>	1	8	0	0	9
<i>Diaulax roddai</i>	0	3	0	0	3
<i>Hillius youngi</i>	0	1	0	0	1
<i>Dioratiopus scotti</i>	0	0	0	1	1
<i>Pseudonecrocarcinus stenzeli</i>	0	6	0	0	6
<i>Prehepatus hodgesi</i>	1	27	2	0	30
<i>Torynomma?</i> <i>densus</i>	0	2	0	0	2

^a Nearly whole palms.

^b Numerous other localities yield *Protocallianassa*.

^c Does not include movable fingers.

km] airline distance east of the courthouse in Burnet, Burnet Co., Texas." Stenzel 1945:437.

4. Junction of Highways 16 and 689, 2.6 km (1.6 mi) east of Bandera; *Salenia texana* zone; collected by Mrs. Henry W. Sebesta, sent to Keith Young by George His.
5. Blackman Ranch, Little Blanco River, Blanco Co., Texas; WSA 16215 collected by A. W. Cleaves.
6. Bluff of Blanco River, 4.8 km (3 mi) west of Blanco, Blanco Co., Texas; *Salenia texana* zone 1.5 m (5 ft) below *Corbula* Bed; UT 45488 (2 specimens) collected by N. B. Waechter.
7. Shingle Hills Section, Travis Co., Texas; *Salenia texana* zone; collected by G. L. Dawe.
8. From a limestone ledge about 1.5 m (5 ft) above water level at Jacob's Well, a spring on Cypress Creek, 1.5 km (3.2 mi) northwest of Wimberley, Hays Co., Texas, about 55 m (180 ft) below the *Corbula* Bed, Lower Glen Rose Limestone (calculated from Young 1974).

FAUNA

The decapod fauna (Fig. 8) of the Glen Rose Limestone consists of 11 taxa (Table 1). *Protocallianassa* sp. is the most abundant taxon, and *Pagurus* and *Prehepatus* are second most abundant. The decapod fauna at each locality forms only a part of a much larger fauna dominated by molluscs.

Preservation.—The fossil decapods of the Glen Rose Limestone are found as disarticulated fragments. Claws are most abundant but a few carapaces are present. The condition of the remains at the time of final entombment can not be determined. The presence of numerous decapod remains is probably due to the similarity of the mineralized exoskeleton and surrounding carbonate rocks. The mineralized exoskeleton is often only represented by a chalky carbonate material that weathers readily. This gives rise to many steinkerns (internal molds). Steinkerns of brachyurans reflect surface morphology but certainly differ significantly from specimens with exoskeletons. The finger tips of claws are often filled with sparry calcite signifying that they were not completely filled with mud at the time of burial.

Decapods.—The Glen Rose decapod fauna (Pls. 1–3) gives a crude measure of the diversity of decapods in North America in the Early Albian. Because of the small size of most of these decapods, they probably are seldom collected and, hence, the anticipated total decapod fauna certainly exceeds that described here. This fauna is the earliest Cretaceous decapod fauna described from North America.

The presence and abundance of hermit crabs (*Pagurus*) in these collections is due to their size, original abundance in the living fauna, and their heavy mineralization. The postulated shallow-lagoonal environment is very compatible with these shallow-water decapods. One specimen of *Pagurus* (Pl. 2, fig. 17) has an oyster attached to its claw. The lack of hermit crab fossils, except claws of pagurids, is due to "the thin exoskeleton everywhere but on the heavily mineralized claws that function as an operculum to close the "borrowed" gastropod shells in which hermit crabs live. *Roemerus robustus* was also probably a hermit crab.

Because this is a large, new fauna there are several extensions of geographic range of the particularly well-known taxa from the Albian of England (Wright and Collins 1972). *Palaeodromites naglei*, *Diaulax roddai*, and *Pseudonecrocarcinus stenzeli* all extend the geographic ranges of the genera from Europe into North America. *Torynomma? densus* extends the range of that genus from Australia to North America. *Dioratiopus scotti* is the second described species of this taxon in North America (the other, *Dioratiopus dawsonensis* (Bishop 1973) is from the Maestrichian of Montana). A third species is present on the north flank of the Black Hills, low in the Pierre Shale.

Hillius youngi is so far known from 1 steinkern. It is hoped that additional material will substantiate the basic diagnostic features of this poorly represented taxon.

Prehepatus hodgesi joins other members of the genus, *P. cretaceous* and *P. pawpawensis* from the Early Cretaceous of Texas, and *P. dilksi* from the Late Cretaceous Merchantville Fm. of Maple Shade, New Jersey. The pattern and variability of ornamenting tubercles on these little claws is extremely interesting. Possibly the variation may be due to sexual dimorphism as in the fiddler crabs and perhaps may even have had some ritualistic or actual function in this crab's behavior.

Callianassids.—The most abundant decapod remains found in this collection and throughout the Glen Rose Limestone are thalassinids belonging to *Protocallianassa*, *Callianassa*, *Axius*, *Jaxea*, or some other closely related taxon. Only the chelae are represented in the collections from the Glen Rose Limestone.

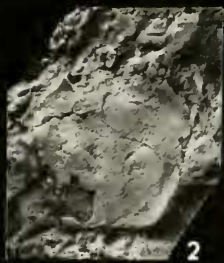
The thalassinids are differentiated on the basis of carapace morphology, and chelation of walking legs. Within a given taxon (such as *Callianassa*) sexual dimorphism, differing morphology of right and left claws, intraspecific variation, and changes in morphology in different instars are all probable (Rathbun 1935:29). These factors seem to have combined to yield a baffling spectrum of chelae morphology. The claws found in the Glen Rose exhibit a wide variation. Morphotypes can be established easily but as the numerous specimens are examined the morphotypes become impossible to maintain. The claws will be analyzed again when a graphic analyzing computer system becomes available.

Microcrustaceans.—The presence of crustacean microfossils in the Glen Rose Limestone was pointed out to me by Peter Rodda while curating the collection of the Texas Bureau of Economic Geology. Subsequently, microfossil residues were prepared from the marls at each locality and numerous other Glen Rose localities. They demonstrated a diverse and abundant crustacean microfauna consisting of claws and dactyli (Pl. 3, fig. 44).

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PLATE I

FIGURES 1–2. *Diaulax roddai*, 1, Dorsal view of carapace, $\times 1.0$; 2, Dorsal view stereo, $\times 2.0$ SDSNH 23640 (orig. GAB 25, specimen 2). FIGURES 3–5. *Pseudonecrocarcinus stenzeli*, Dorsal view of latex cast of carapace; 3, $\times 1.0$; 4, stereo, $\times 2.0$; 5, view of impression of carapace in limestone, $\times 1.0$, SDSNH 23641 (orig. GAB 25, specimen 8). FIGURES 6–7. *Dioratiopus scotti*, 6, Dorsal view of carapace, $\times 1.0$; 7, Dorsal, stereo, $\times 2.0$, SDSNH 23642 (orig. GAB 27, specimen 1). FIGURE 8–11. *Hillius youngi*, 8, Carapace, $\times 1.0$; 9, Carapace, stereo, $\times 2.0$; 10, Anterior of Carapace $\times 2.0$; 11, Right side of carapace, $\times 2.0$, SDSNH 23643 (orig. GAB 25, specimen 3). FIGURES 12–17. *Palaeodromites naglei*, 2–13, Carapace, Holotype SDSNH 23644 (orig. GAB 25, specimen 1); 12, $\times 1.0$; 13, stereo, $\times 2.0$; 14–17, Carapace features of specimen SDSNH 23645 (orig. GAB 21, specimen 21) collected by Nagle; 14, Dorsal, $\times 1.0$; 15, Dorsal of carapace, $\times 2.0$.



2



1



4



3



5



7



6



9



8



10



11



13



12



16



15



14



17

TABLE 2. Measurements in millimeters of the major claw of *Protocallianassa klofi*.

Specimen*	Right or left	Propodal length (mm)	Palm length (mm)	Palm height (mm)
25-67	R	13.7	9.8	7.7
25-160	R		8.0	7.0
25-153	L		9.2	8.6
SDNHM 23665 (=25-152)	R		9.2	8.5
25-87	L		10.7	9.8
25-116	R	15.6	11.0	9.2
25-133	L		10.8	9.3
25-124	L	10.9	7.0	6.0
25-123	R	9.8		6.6
25-144	R			
25-127	R		8.2	5.8
25-164	R	8.1	6.8	5.4
25-136	L	8.5	6.7	5.8

* Specimens in the tables are listed by locality number followed by the specimen number (e.g. 25-67 is locality GAB25, specimen 67).

SYSTEMATIC PALEONTOLOGY

Order Decapoda Latreille 1803
 Suborder Pleocyemata Burkenroad 1963
 Infraorder Anomura H. Milne-Edwards 1832
 Superfamily Thalassinioidea Latreille 1831
 Family Callianassidae Dana 1852
 Subfamily Protocallianassinæ Beurlen 1930
 Genus *Protocallianassa* Beurlen 1930

Type species.—*Callianassa archiaci* A. Milne-Edwards 1860 by original designation.

Diagnosis.—“Carapace with *linea thalassinica*; first pereopods with well developed chelae, heterocheulous; abdomen with pleura developed on second to sixth somites; uropods without diaeresis . . . (Single chelae are hardly distinguishable from those of *Protaxius* or *Callianassa*).” (Glaessner 1969:478).

Protocallianassa klofi new species

Pl. 3, figs. 41-43; Fig. 8I; Tab 2

Type.—The holotype, a right major propodus (orig. GAB 25, specimen 152) is deposited in the San Diego Natural History Museum (SDNHM 23665).

PLATE 2

FIGURES 1-16. Right chelae of *Pagurus banderensis*. 1-5, Specimen SDSNH 23646 (orig. GAB 25, specimen 7). 1, Outer face; 2, Inner face, 3, Bottom, and 4, Top; $\times 2.0$. 5, Outer face, $\times 1.0$. 6-8, Specimen SDSNH 23647 (orig. GAB 21, specimen 17). 6, Outer face and 7, Inner face; $\times 2.0$; 8, Outer face, $\times 1.0$. 9-12, Specimen UT 45473 (Univ. Texas, Austin). 9, Outer; 10, Inner; 11, Lower; and 12 Top, $\times 1.0$. 13-15, Specimen SDSNH 23648 (orig. GAB 26, specimen 5). 13, Outer; 14, Inner; and 15, Top $\times 2.0$. 16, Specimen WSA 16215 (Univ. Texas, Austin), Outer face with walking leg, $\times 1.0$. FIGURES 17-25. Left chelae of *Pagurus banderensis*. 17, Specimen SDSNH 23649 (orig. GAB 26, specimen 3), Inner face of left claw with attached oyster, $\times 2.0$. 18, Specimen SHSNH 23650 (orig. GAB 26, specimen 4). Outer face of propodus, $\times 1.0$. 19, Specimen UT 45488, Outer face of claw, $\times 1.0$. 20-21, Specimen SDSNH 23651 (orig. GAB 25, specimen 11), Outer (20), Inner (21), faces of nearly complete minor claw, $\times 1.0$. 22-25, Specimen SDSNH 23652 (orig. GAB 26, specimen 1), Outer (22), Inner (23), Bottom (24), and Top (25) views, $\times 2.0$. FIGURES 26-31. Dactyli of *Pagurus banderensis*. 26-29, Specimen SDSNH 23653 (orig. GAB 26, specimen 12), Dactylus of walking leg, $\times 2.0$. 30-31, Specimen SDSNH 23654 (orig. GAB 26, specimen 11), Dactylus of major claw, 30, Side $\times 1.0$ and 31, Occlusional surface, $\times 2.0$.

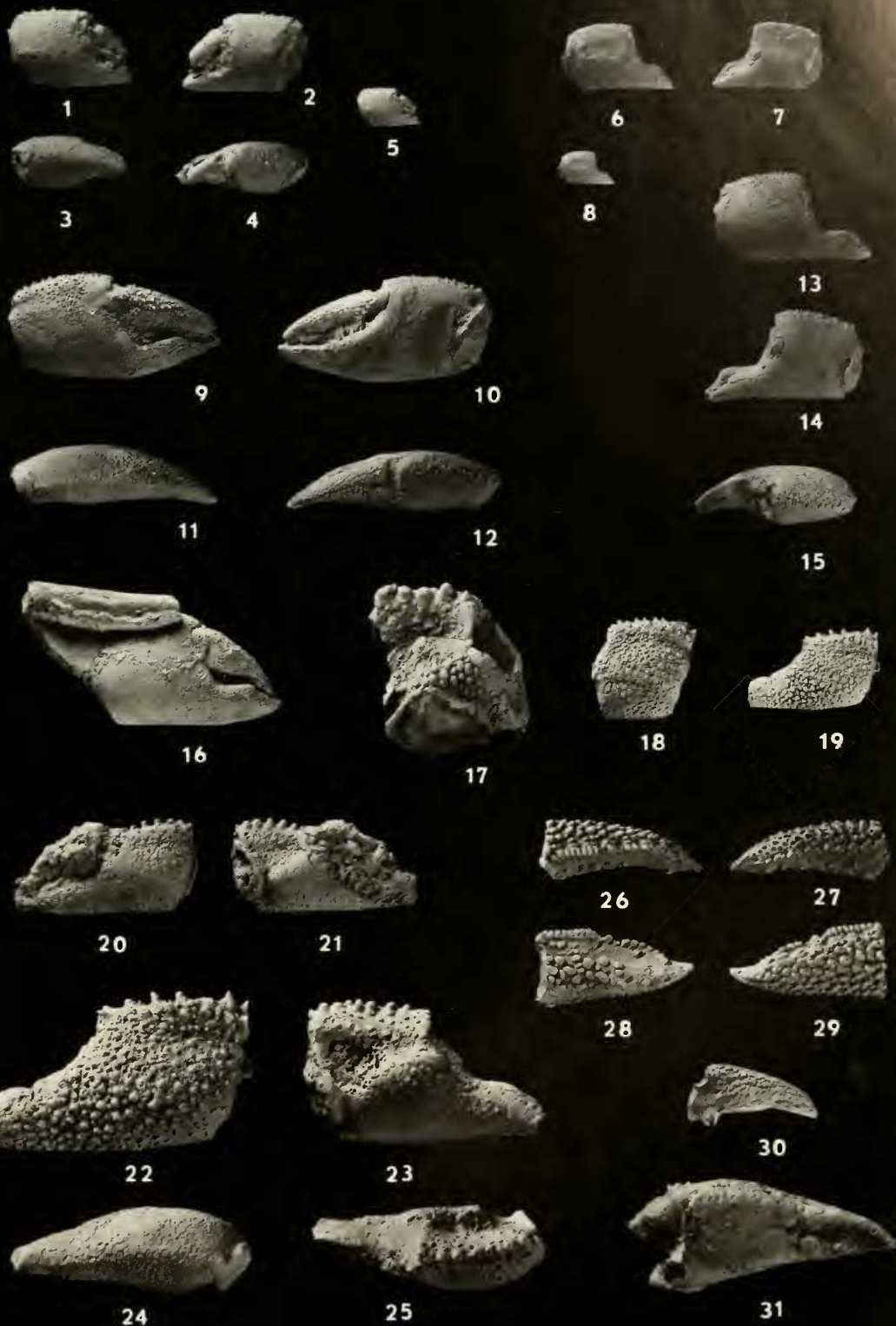


TABLE 3. Height (H), length (L), thickness (T) in millimeters, and height/thickness (H/T) ratios of claws of *Pagurus banderensis*.

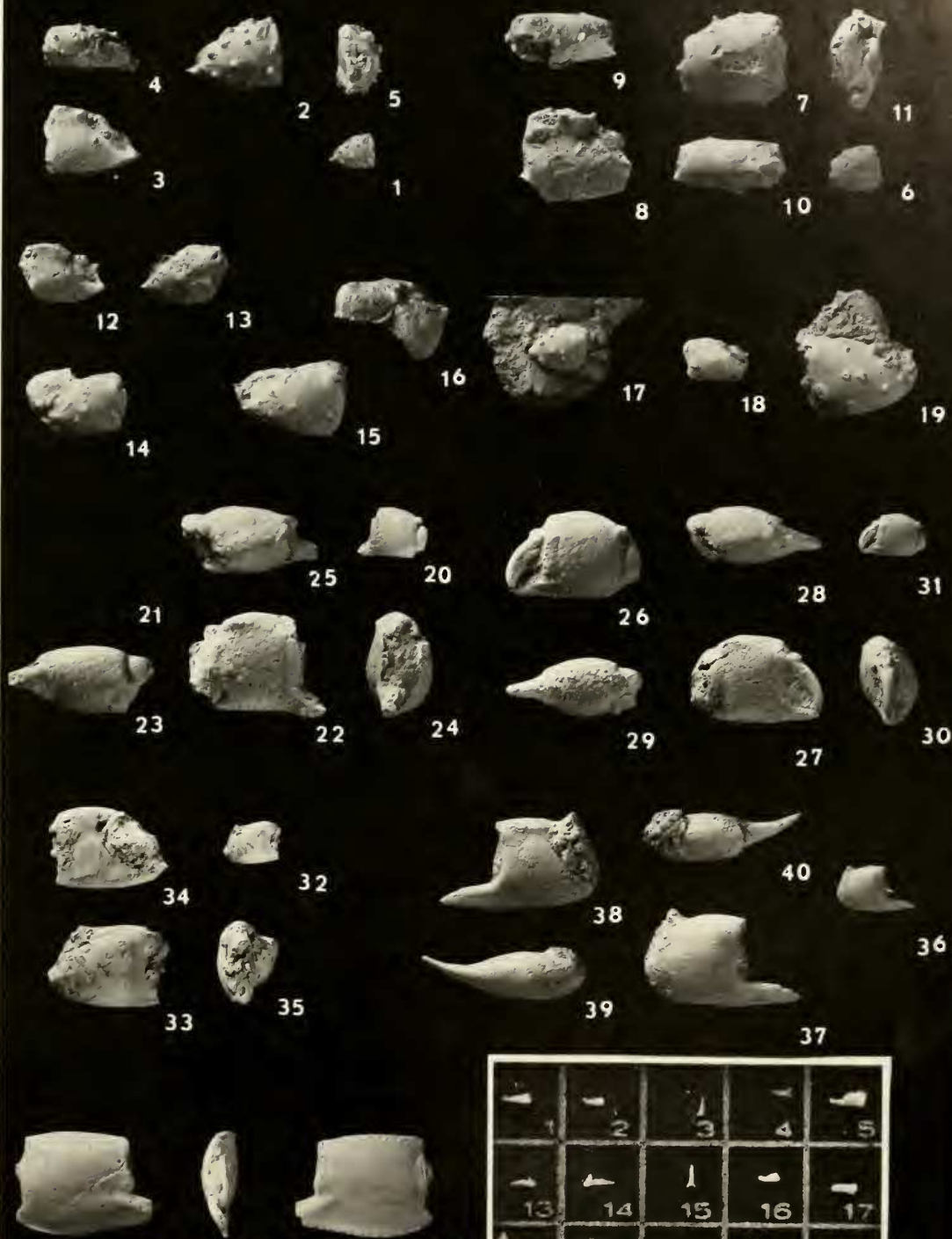
	Height (mm)	Length (mm)	Thickness (mm)	H/T*
<i>Right Claw</i>				
25-22	3.7	5.5	1.9	1.90
25-23	4.2	7.3	2.5	1.70
SDNHM 23647 (=21-17)	4.9	8.6	2.3	2.09
25-25	5.4	9.8	3.6	1.52
25-24	5.6	7.5*	3.4	1.65
SDNHM 23646 (=25-7)	6.0	9.74+	4.0	1.51
25-26	10.2	15.7*	6.3	1.62
25-28	10.6	19.2		
26-14	10.8		7.2	1.49
25-27	11.9	18.7	5.7	2.09
SDNHM 23648 (=26-5)	13.8	23.8	9.0	1.54
Stenzel	14.2	26.7	9.0	1.57
UT 45473	16.3	32.4	9.3	1.75
26-16	17.0		11.1	1.53
WSA 16215	17.9	30.2*	11.4	1.57
26-6	19.7		11.8	1.67
26-19	20.0		11.8	1.69
Stenzel**	22.8		10.8	2.11
<i>Left Claw</i>				
SDNHM 23651 (=25-11)	7.1	14.3	4.47	1.56
Stenzel	7.4	16.2	5.1	1.45
25-31	7.5	10.8*	4.94	1.51
25-30	7.5*		5.12	1.46
25-29	7.6	15.2*		
26-15	10.1		6.27	1.61
26-7	10.3	16.8+	7.34	1.40
SDNHM 23652 (=26-1)	10.9	17.9	6.50	1.67
SDNHM 23649 (=26-3)	11.4		7.8	1.46
26-2	11.5		7.4	1.55
UT 45488	11.8	20.5*	8.86	1.33
UT 45488	13.9	19.8*	8.90	1.56

* Calculated before rounding thickness measurements from hundredths of a mm.

** Stenzel's holotype of *P. travisensis*.

PLATE 3

FIGURES 1-19. *Prehepatus hodgesi*. 1-5, Holotype, Specimen SDSNH 23655 (orig. GAB 25, specimen 14); Outer surface of propodus, $\times 1.0$, 2-5, Outer, Inner, Top, and Distal views of propodus, $\times 2.0$. 6-11, Specimen SDSNH 23656 (orig. GAB 26, specimen 9); 6, Outer face of propodus, $\times 1.0$; 7-11, Outer, Inner, Top, Bottom, and Distal views, $\times 2.0$. 12-13, Specimen SDSNH 23657 (orig. GAB 25, specimen 16); 12, Inner face and 13, Outer face of propodus, $\times 2.0$. 14-16, Specimen SDSNH 23658 (orig. GAB 25, specimen 137), articulated carpus and propodus in oblique (14), Front, (15), and Top view (16), $\times 2.0$. 17, Specimen SDSNH 23659 (orig. GAB 21, specimen 22), complete propodus and disarticulated dactylus in front view, $\times 2.0$. 18, Specimen SDSNH 23660 (orig. GAB 25, specimen 18), left propodus in front view, $\times 2.0$. 19, Specimen SDSNH 23661 (orig. GAB 25, specimen 15), left propodus in front view, $\times 2.0$. FIGURES 20-31. *Roemerius robustus*. 20-25, Specimen SDSNH 23662 (orig. GAB 26, specimen 8). 20, Outer view, $\times 1.0$. 21-25, Views of outer face, inner face, bottom, distal end, and top of left propodus. 26-31, Holotype, Specimen UT 45704. 31, Outer view, $\times 1.0$. 26-30, Outer, inner, top and bottom views, $\times 2.0$. FIGURES 32-40. *Torynomma? densus*. 32-35, Paratype Specimen SDSNH 23663 (orig. GAB 25, specimen 10), 32, Outer view, $\times 1.0$. 33-35, Outer, inner and distal views $\times 2.0$. 36-40, Holotype, right propodus, Specimen SDSNH 23664 (orig. GAB 25, specimen 5), 36, outer, $\times 1.0$. 37-40, Outer, inner, bottom, and top views, $\times 2.0$. FIGURES 41-43. *Protocallianassa klofi*. Holotype, Right major propodus, Specimen SDSNH 23665 (orig. GAB 25, specimen 152). 41-43, Outer, distal, and inner views, $\times 2.0$. FIGURE 44. Slide of microcrustacean appendage elements, $\times 3.25$.



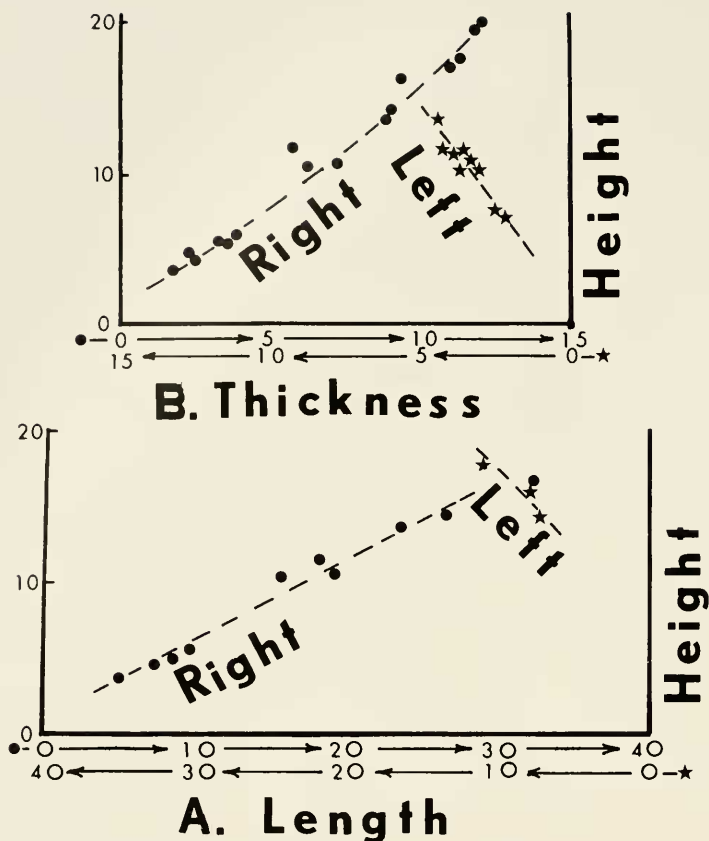


FIGURE 9. Graph of A. height (mm) vs. length (mm) (bottom) and B. height (mm), vs. thickness (mm) of *Pagurus banderensis* Rathbun 1935. Right claws plotted as dots (read thickness or length on upper scale increasing from left to right) and left claws as stars (read thickness of length on lower scale increasing from right to left).

Occurrence, sample size, and preservation.—Fourteen specimens of this taxon were collected at GAB 25 and 1 at GAB 21. Most are preserved as single isolated propodi with chalky exoskeleton over a firm micrite filling.

Etymology.—Named in honor of L. R. Klof, Texas sedimentologist, who often exhibited nocturnal and fossorial habits.

Description.—Propodus flat, broad, nearly twice as long as high. Palm rectangular, slightly longer than high, thin. Upper margin bowed slightly into convex arch. Proximal (carpal) edge nearly vertical. Distal margin slants slightly outward to top of short fixed finger. Two sinuses present on back of hand along margin; uppermost about $\frac{1}{2}$ the distance to top of the fixed finger, the second lies immediately above fixed finger. Lower margin convex proximally and concave beneath base of fixed finger. Lower proximal corner produced into a rounded projection. Propodus convex on outer face (back of hand), nearly flat on inner face (palm). Convexity of outer face continues onto rounded upper margin which overhangs inner side (palm) forming a shallow depression along top of inner side (palm) parallel to upper margin. Another shallow depression parallels the wedge-shaped lower margin on palm. Lower margin of outer side produced into a narrow keel from proximal edge almost to base of fixed finger.

Fixed finger short, nearly horizontal and turned inward. Most large specimens with axillary ridge along outer edge of occlusional surface of fixed finger, terminating in tooth-like projection. An oblique ridge runs off propodus onto fixed finger on back of hand (outer side and on palm [inner side]).

Convex outer face ornamented by 4 or 6 large hair pits along ridge running onto finger. Four hair pits arranged in a horizontal row just above level of sinus immediately above base of fixed finger. One hair pit situated just above uppermost sinus. Three hair pits form broad-based isosceles triangle just below proximal edge of finger ridge. Four to 8 hair slits slant upward and distally along lower margin just above fine keel.

Palm (inner face) has approximately 10 downward and distally slanting hair slits along upper margin just beneath overturned angulated edge where flat palm meets the convex outer face. Approximately 15 hair slits slanting upward and distally situated along lower edge of palm.

Comparison.—*Protocallianassa klofi* is similar to *P. praecepta* Roberts 1962 but differs from it by having a relatively shorter palm, a rounded lower proximal corner, and lacking the ridge at the base of the fixed finger on the inner face.

Remarks.—The minor chela of this taxon is not as yet known. No pairs of chelae were found preserved together to directly tie the major and minor chelae to one another.

Protocallianassa sp.

The majority of the specimens referable to *Protocallianassa* comprise a highly variable series of chelae. Attempts to differentiate morphotypes failed except in the case of *P. klofi* because gradations were found between all other morphotypes I attempted to establish.

The claws vary from proximally expanded, through rectangular, to nearly oval in shape. The cross-sectional shape varies from biconvex, through convex on the other face, to spatulate. The fixed fingers are usually curved slightly inward. Ornamentation by hair pits is extremely variable.

Superfamily Paguroidea Latreille 1803

Family Paguridae Latreille 1802

Subfamily Pagurinae Latreille 1802

Genus Pagurus Fabricius 1775

Type species.—“*Cancer bernhardus* Linne 1758” (on official list, ICZN); subsequent designation Latreille 1810 = *Eupagurus* Brandt 1851 (type, *Cancer bernhardus* Linne’ 1758; subsequent designation Stimpson 1858) (obj.).” (Glaessner 1969:R479).

Diagnosis.—“Chelipeds usually dissimilar and unequal, right being much larger than left, very rarely subequal; 4th periopods subchelate.” (Glaessner 1969:R479).

Pagurus banderensis Rathbun 1935

Pl. 2, figs. 1–31; Figs. 8H, 9; Tab. 3

Pagurus banderensis Rathbun 1935, p. 39, Pl. 9, figs. 7, 8.

Pagurus banderensis (Rathbun); Stenzel 1945, p. 435, Pl. 45, figs. 7–15.

Palaeopagurus banderensis (Rathbun); Roberts 1962, p. 175.

Occurrence.—Specimens of *Pagurus banderensis* have been collected at many localities including GAB 21, GAB 25, GAB 26, and Localities 1–7.

Previous descriptions.—See Rathbun 1935:30 and Stenzel 1945:435–437.

Remarks.—The collections made at GAB 25 and GAB 26 give the first suites of specimens of *P. banderensis*. Height, length, and thickness data were gathered (Table 3) and are presented graphically in Fig. 9.

Size variation is much greater in the right claw than in the left claw. This generalization also carries over to their morphology and ornamentation; the right claws are highly variable in shape, cross section, and degree of granulation, whereas the left claws are more consistent in shape and ornamentation. Small right (major) chelae tend to have a straighter lower margin which becomes gently convex as size increases. There seems to be a tendency for a single row of upper margin granules in small sizes and 2 distant rows (surrounded by many smaller granules) in larger specimens.

Two specimens (GAB 21, specimen 17 and GAB 25, specimen 27) are thinner

TABLE 4. Measurements in millimeters of claws of *Roemerus robustus*.

	Total length (mm)	Height (mm)	Palm length (mm)	Thickness (mm)	Claw
UT 45704	10.5	7.75	6.75	4.5	Left
SDNHM 23662 (=26-8)	10.4	8.9	7.8	5.1	Left
25-162	6.7	5.0	4.7	2.6	Right
25-163	6.8	5.1	4.6	3.2	Left
25-165	6.3	5.8	8.3	3.9	Right

than the others (H/T-1.62) and might have been called *P. travisensis* (H/T-2.11) by Rathbun. I consider these thinner specimens to be *P. banderensis* until such time as sufficient material becomes available to clearly separate them as *P. travisensis* upon the basis of shape, or until the left (minor) claw of *P. travisensis* can be demonstrated to exist.

One other specimen (GAB 25, specimen 26) is different enough to merit special consideration. The upper margin is narrow and the claw pear-shaped in cross section. In front view the lower margin is straight and the upper and lower margins highly divergent.

A walking leg is preserved with a large major chela (Pl. 2, fig. 16). A fragment of a dactylus of a walking leg is also figured (Pl. 2, figs. 26-29). A fairly common element in the collections is the movable finger belonging to this taxon (Pl. 2, figs. 30-31).

Family Paguridae Latreille 1802
Subfamily Uncertain
Roemerus new genus

Type species.—*Roemerus robustus* new species.

Diagnosis.—Chelae elongate, similar, with rectangular palm, outer face transversely convex, inner flat. Carpal and dactyl articulations perpendicular to lower margin which is straight except for convexity below base of fixed finger. Fingers short and turned slightly inward. Fixed finger has at least 1 proximal tooth. Tip of movable finger overlaps fixed finger in smaller claws and closes onto outer edge of tip in large claws. Surface sparsely covered with large, low granules which become numerous and prominent on lower edge. The upper surface surmounted by a low, oblique ridge accentuated on the proximal inner face by a few low granules and becoming less conspicuous as it runs toward the top center of the distal margin of the claw.

Etymology.—In honor of Ferdinand Roemer, pioneer geologist and paleontologist of Texas and México.

Comparison.—This claw is similar to *Palaeopagurus* Van Straelen 1925 but differs in being more rectangular, having a more vertical distal margin, and having a slightly upturned fixed finger instead of slightly downturned. *Roemerus robustus* is easily distinguished from *Pagurus banderensis* Rathbun 1935 by its rectangular shape.

Roemerus robustus new species
Pl. 3, figs. 20-31; Fig. 8G; Tab. 4

Types.—The holotype, a left propodus and dactylus (UT 45704), was collected by G. L. Dawe from the *Salenia texana* marl at Shingle Hills, Travis Co., Texas. The paratype, a left propodus (orig. GAB 26, specimen 8), was collected at GAB 26. The holotype is deposited at the Univ. of Texas (Austin) as UT 45704. The paratype is deposited in the San Diego Natural History Museum (SDSNH 23662).

Occurrence, sample size, and preservation.—Five specimens of *Roemerus robustus* were available for description; 1 from Shingle Hills (UT 45704), 1 from (GAB 26), and 3 from (GAB 25).

Etymology.—The name is taken from the robust nature of the claws of this taxon.

Description.—Claws robust, similar, rectangular, and thick. Palm slightly longer

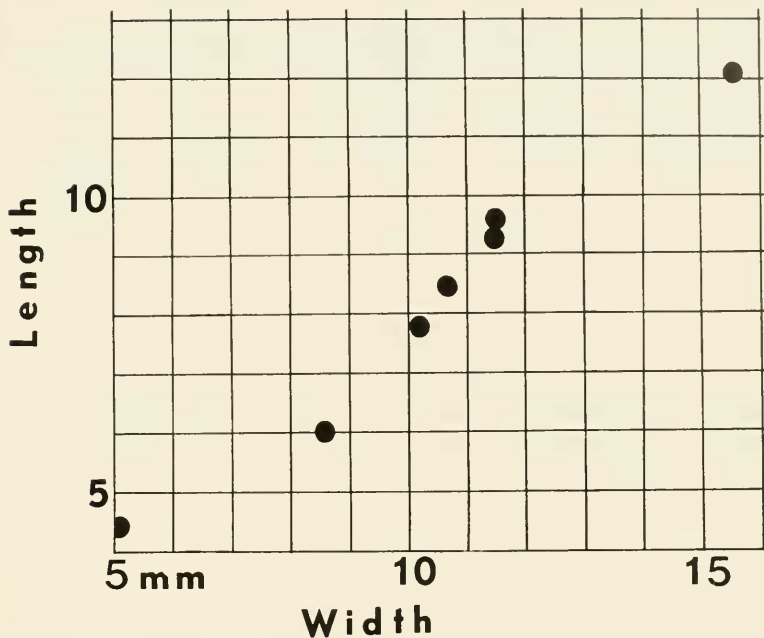


FIGURE 10. Graph of carapace width (mm) vs. length (mm) of *Palaeodromites hodgesi* Bishop.

than high and fingers short, slightly incurved, movable finger overlapping tip of fixed finger.

Lower edge straight except for slight convexity below base of fixed finger. Proximal edge perpendicular to lower margin. Distal edge, above the fixed finger vertical. Upper margin convex, especially proximally, where it curves down onto prominent carpal articulator.

Outer face transversely convex and ornamented by broad ridges along proximal and distal edges formed by narrow furrows on inside. Surface covered by sparse, large, subdued granules except for lower edge which has numerous, large, prominent granules.

Inner face relatively flat and ornamented by a distal ridge and a bend in the exoskeleton near proximal margin forming a groove.

Upper margin surmounted by an oblique ridge which runs from outer-distal corner to inner-proximal corner and is progressively more pronounced proximally until it forms a noticeable low ridge on upper edge of inner face. A few large granules may accentuate ridge.

At least 1 tooth can be seen situated on fixed finger near its base.

Comparison.—*Roemerus robustus* differs from most other pagurids by having a pronounced rectangular shape. Only *Palaeopagurus* Van Straelen 1925 and *Petrochirus* Stimpson 1859 even approach this shape.

Infraorder Brachyura Latreille 1803
 Section Dromiacea deHaan 1833
 Superfamily Domiodea deHaan 1833
 Family Dynomenidae Ortmann 1892
 Genus *Palaeodromites* A. Milne-Edwards 1865

Type species.—By monotypy; *Palaeodromites octodentatus* A. Milne-Edwards 1865, p. 345, pl. 5; Hauterivian of France.

Diagnosis.—Carapace broader than long, rounded pentagonal or hexagonal, widest two-thirds from front, gently arched transversely and longitudinally. Front square to trapezoidal, turned strongly downward; orbits large, oval, widely spaced. Anterolateral

TABLE 5. Measurements in millimeters of the carapace of *Palaeodromites naglei*.

Specimen	Length (mm)	Width (mm)
SDNHM 23644 (=25-1)	8.5	10.7
25-4	9.3+	11.5+
25-52	6.0?	8.6?
25-53	7.8+	10.2
25-54	4.4	5.1
25-57	9.6+	11.5
SDNHM 23645 (=21-21)	12.1	15.6

borders convex with tooth-like spines or lobes, posterolateral borders short, straight, or concave without tooth-like lobes, hind margin short, straight, or concave. Cervical furrow clearly defined, sinuous to straight; branchiocardiac furrows weakly defined. (After Wright and Collins 1972:49).

Palaeodromites naglei new species
Pl. 1, figs. 12-17; Figs. 8A, 10; Tab. 5

Types.—The holotype SDSNH 23644 (orig. GAB 25, specimen 1) and paratype SDSNH 23645 (originally GAB 21, specimen 21) of *Palaeodromites naglei* are both carapaces and are deposited in the San Diego Natural History Museum.

Occurrence, sample size, and preservation.—*Palaeodromites naglei* has been found at GAB 21 and GAB 25.

Etymology.—In honor of J. Stuart Nagle, who discovered the first specimen of this taxon.

Description.—Carapace hexagonal, 1.2 times wide as long, very convex longitudinally, less convex transversely. Carapace furrows poorly developed, a faint cervical furrow and 3 branchial furrows present. Rostrum rounded, nearly vertical. Orbits poorly defined in dorsal view arching upward. Width between outer angles of orbits 57% carapace width. Mesogastric region barely set off from rest of cephalic arch. Three faint grooves on branchial region parallel cervical furrow. Metagastric and protogastric regions set off from the cardiac and branchial regions by faint muscle attachment scars. Hind margin paralleled by a marginal groove.

Branchial regions split into 4 fields by very faint grooves; anteriormost parallels the cervical furrow to a point behind outer angle of orbit then banks backward and outward to back of first lateral spine. Second groove beginning at anterior end of muscle attachment field, trends outward to first lateral spine. Third furrow extremely faint, lying just inside a ridge paralleling posterolateral margin.

Anterolateral margins each composed of 4 forward facing broad spines which get progressively larger posteriorly; the first little more than a broadening of the carapace edge just behind outer angle of orbit, the second asymmetrical, bent slightly forward, the third the shape of an equilateral triangle, and the fourth broadly rounded, forming the widest part of carapace.

Posterolateral margin serrated by a series of 3 or 4 spines which decrease rapidly in size to the last which is little more than a granule, anteriormost a small spine on the dorsal shield edge about the size of second anterolateral spine.

The ventral side and appendages presently unknown because none of these parts definitely attached to a carapace.

Comparison.—*Palaeodromites naglei* is much smoother and less ornamented than other species of this genus. *Palaeodromites naglei* is additionally distinguished from *P. sinusosulcatus* Wright and Collins 1972 by a straight cervical furrow and lower convexity, from *P. incertus* (Bell 1863) by the lack of coarse granulation, and from *P. transiens* Wright and Collins 1972 by the lack of posterolateral ornamentation.

TABLE 6. Carapace measurements in millimeters of *Diaulax roddai*.

Specimen	Width (mm)	Length from front orbit to hind margin (mm)	Orbital width (mm)	Rostral	
				Width (mm)	Length (mm)
SDNHM 23640 (= 25-2)	10.6	10.7	6.8		
25-58	5.8		4.0	1.6	1.0+
25-161	6.6	6.1+	4.2		

Family Diaulacidae Wright and Collins 1972
Genus *Diaulax* Bell 1863

Type species.—*Diaulax carteriana* Bell 1863, by original designation.

Diagnosis.—“The carapace is more or less hexagonal, widest just in front of or just behind the ends of the cervical furrow, in longitudinal section curved more or less steeply down anteriorly but flat posteriorly, in transverse section flat. The front is generally downturned, pointed or squared; it may be sulcate with the edges turned up into prominent lobes or nearly flat. The antero- and posterolateral margins are very sharp, not lobed and with only a few small, sharp spines directed forwards. The cervical and branchiocardiac furrows are weak and tend to be straight and transverse. The regions are poorly defined. The surface is very finely granulate.” (Wright and Collins 1972:56).

Diaulax roddai new species
Pl. 1, figs. 1-2; Fig. 8E; Tab. 6

Type.—The holotype, a partial carapace (orig. GAB 25, specimen 2) is deposited in the San Diego Natural History Museum, SDSNH 23640.

Occurrence, sample size, and preservation.—The holotype is 1 of 3 specimens of this taxon thus far collected. It is an almost complete carapace missing only the rostrum and left rear corner of the carapace. The exoskeleton is preserved as a chalky limestone and does not show surface ornamentation very well. One specimen (GAB 25, specimen 58) has a partly preserved rostrum and the third specimen (GAB 25, specimen 161) is a poorly preserved, crushed carapace.

Etymology.—For Peter U. Rodda, Curator of Geology, California Academy of Sciences, whose encouragement led to the completion of this study.

Description.—Carapace kite-shaped with truncate anterior and posterior slightly longer than wide, widest about $\frac{1}{3}$ distance from front. Large specimens flat with raised anterolateral margins turned slightly under the dorsal shield on pterygostomial regions; smaller specimens with higher relief.

Cervical groove indistinct except for notch where it meets edge of the dorsal shield near widest part of carapace. Epimeral muscle scars present but not deeply incised.

Regions poorly differentiated; rostrum fairly broad, long. Cephalic arch dominated by spines at outer edges of orbits and raised anterolateral margins running from orbital spines to cervical notch. Gastric areas slightly higher than rest of cephalic arch with slight protogastric bosses. Distance between outer edges of orbits $\frac{2}{3}$ the carapace width. Scapular arch flat, undifferentiated except for epimeral muscle scars and slight bosses distal to epimeral peninsulas, forming ridges that continue almost to hind margin.

Anterolateral margins dominated by large upward and forward pointing spines at outer edge of upward turned orbits that have a single fissure on lower edge, raised margin concave to cervical notch. A large upward, forward pointing spine and a second, smaller spine lie on margin behind cervical notch (second spine about same distance behind notch as orbital spine is ahead of it). Dorsal shield margin convex to first scapular spine and runs almost in a straight line to concave V-shaped posterior margin. Hind margin bordered by furrow.

Comparison.—*Diaulax roddai* is distinguished from *D. oweni* (Bell 1850) and *D. carteriana* Bell 1863 by being relatively longer and more flat, especially longitudinally. *Diaulax roddai* most resembles *D. feliceps* Wright and Collins 1972 but is relatively longer, has its maximum width further forward, and has a longer rostrum.

Remarks.—Small specimens of this taxon appear to have a better differentiated carapace than larger specimens.

Superfamily Dorippoidea de Haan 1841
Family Dorippidae de Haan 1841
Subfamily Dorippinae de Haan 1841
Hillius new genus

Type species.—*Hillius youngi* new species

Diagnosis.—Carapace pentagonal, fairly flat, slightly wider than long, widest half the distance from front. Grooves broad and indistinct. Rostrum broad. Orbital width 50% carapace width, orbits small, upturned, notched near inner corner, with raised rim. Epibranchial areas wide, giving specimens a wing-like or ray-like appearance.

Etymology.—For Robert Thomas Hill, pioneer Texas geologist, stratigrapher, and paleontologist.

Comparison.—This taxon has a striking resemblance in carapace shape to *Dorippe* Weber 1795, *Goniochele* Bell 1858, and *Orthopsis* Carter 1872. It differs from *Dorippe* by having a wider front with convex anterolateral margins. *Hillius* differs from *Goniochele* by having the widest part of the carapace relatively more forward and formed by the epibranchial lobes. *Hillius* is most similar to *Orthopsis* but differs from it by its having less relief, lack of anterolateral spination, and single orbital lobe.

Hillius youngi new species
Pl. 1, figs. 8–11; Fig. 8C

Type.—The Holotype, a carapace steinkern (orig. GAB 25, specimen 3), is deposited in the San Diego Natural History Museum (SDSNH 23643).

Occurrence, sample size, and preservation.—The Holotype is the only specimen of this taxon's carapace that is nearly complete. The specimen was collected at GAB 25. As with any description from decorticated specimens only major ornamentation features are likely to be decipherable, and a specimen with exoskeleton will be needed to completely define this taxon.

Etymology.—In honor of Keith Young, Texas Cretaceous stratigrapher and paleontologist.

Description.—Carapace pentagonal, probably slightly wider than long (partial length 11.5 mm), widest about half the distance from the front. Carapace slightly convex longitudinally; cephalic arch moderately convex transversely, scapular arch fairly flat transversely, except at the edges.

Cervical furrow broad and indistinct except where it crosses dorsal shield margin in a pronounced notch continuing on subhepatic region as a well-defined groove to base of orbit. An indistinct groove on subhepatic region lies above and is parallel to cervical furrow. Faint but distinct mesogastric grooves present. Hepatic grooves broad and poorly defined. The most prominent grooves on carapace separate gastrocervical region from branchial regions. Broad grooves separate urogastric, cardiac, and intestinal regions, two faint grooves separate branchial regions into 3 parts, the anterior runs over carapace edge just behind lateral spine then swings rapidly forward toward cervical furrow. Rostrum about $\frac{1}{4}$ carapace width. Orbits small, upturned, with notch near inner corner, with raised rim. Distance between outer edges of orbits about 50% carapace width. Cephalic arch differentiated into small mesogastric area; large protogastric area surmounted by large, low circular bosses; and an upturned hepatic region with at least 2 small marginal spines immediately ahead of cervical notch. Scapular arch well differentiated into a segmented medial ridge (consisting of urogastric, cardiac, and intestinal regions) and branchial regions (divided into epibranchial, mesobranchial, and

metabran­chial regions). Urogastric regions have a gentle forward slope and a steep posterior slope giving rise to 2 transverse crescentic ridges with small medial spine where they meet. Cardiac region diamond-shaped with 2 tubercles symmetrically placed across medial axis. Intestinal region poorly defined and partly missing, a single medial intestinal tubercle near hind margin. Short longitudinal ridges lie in each gastrobranchial groove, perhaps the ridges formed within the epimeral muscle scars. Epibranchial region small but forming the prominent lateral wing of this taxon. A small marginal epigastric spine lies in posterior part of cervical notch. Two small spines are situated near lateral margin of epibranchial wing; the anterior smaller and the posterior larger. Mesobran­chial and metabran­chial regions with fairly continuous broad longitudinal ridges from near the epibranchial groove to hind margin. Posterior of mesobran­chial region with small boss on this ridge, surmounted by several granules. A small marginal spine situated at anterior of metabran­chial region. Hind margin missing.

Comparison.—*Hillius youngi* differs from *Orthopsis bonneyi* Carter 1872 by its lack of anterolateral spines, single instead of double orbital lobe, more subdued carapace relief, and different carapace outline due to the widest point of the carapace being farther forward.

Remarks.—The line drawing of the carapace of this taxon is based on a single steinkern. When further material becomes available the description should be amended to include surface ornamentation.

Family Tornyommidae Glaessner 1980
Genus *Dioratiopus* Woods 1953

Dioratiopus Woods 1953, p. 52; Wright and Collins 1972, p. 33, 34, 42.

Doratiopus Woods, Glaessner 1969, p. 492 (erroneous spelling).

Glaessneria Wright and Collins 1972 (*non* Takeda and Miyake 1964), p. 34 ff.

Glaessnerella Wright and Collins 1975, p. 441.

Type species.—*Homolopsis spinosa* (Van Straelen 1936), p. 33; Albion of Valcourt France.

Diagnosis.—“Carapace more or less pentagonal with parallel sides, strongly projected frontal area, long rostrum with lateral spines and large shallow indistinct orbits complete above; the sides are vertical and there are traces of a lateral margin anteriorly, but it is normally not sharp or fully developed; the cervical and branchiocardiac furrows are strongly marked; a short oblique furrow runs forward from the outer end of the branchiocardiac and may extend as far as the cervical, delimiting an epibranchial lobe; there is a strong postorbital spine at or just behind the anterolateral angle.” (Wright and Collins 1972:34).

Dioratiopus scotti new species
Pl. 1, figs. 6–7; Fig. 8D

Type.—The holotype, a partial carapace steinkern (orig. GAB 27, specimen 1), collected at Jacob’s Well, Hays Co., Texas, is deposited in the San Diego Natural History Museum (SDSNH 23642).

Occurrence, sample size, and preservation.—The holotype is the only specimen of this taxon so far collected. It is decortiated carapace steinkern preserving most of the dorsal shield.

Etymology.—For Alan J. Scott, Texas Cretaceous and Holocene paleontologist and stratigrapher.

Description.—Carapace rectangular, longer (partial length 7.9 than wide (partial width 6.8 mm). Cephalic arch moderately convex transversely; scapular arch fairly flat transversely; carapace relatively level longitudinally.

Cervical furrow narrow, deep, and prominent; dorsally parallel to anterior dorsal shield edge, turning inward and backward, then backward for a short distance cutting across medial ridge. Branchiocardiac furrow crosses carapace just behind cervical fur-

row. Furrows parallel to point where cervical furrow bends inward to cross medial ridge, from where branchiocardiac furrow continues backward joining epimeral muscle scars and splitting at point near posterior epimeral muscle scar, 1 part swinging inward crossing medial ridge as a broad, poorly defined groove and other continuing as epimeral muscle scar. Outer arm of epimeral muscle scar loops back inward forming small, flat, oval area. Well-defined branchial furrow splits off epimeral muscle scar near where it begins the loop, proceeds outward and forward to dorsal shield edge.

Rostrum probably triangular, occupying 40% carapace width. Orbits apparently small; with sharply upturned rims, occupying 55% carapace width. Mesogastric area separated from broad, swollen protogastric regions by shallow, distinct groove, narrow anteriorly but rapidly widening at posterior half. Protogastric region with small circular boss situated at center. A row of 12 small granules begins on raised orbital rim and forms an incomplete circle to mesogastric grooves around each protogastric boss. The region lying between 2 transverse grooves, crescent-shaped, concave side anterior, with short transverse base posterior to middle, giving rise to 2 transverse ridges. Medial area behind, where the second groove crosses, a raised region separated by a shallow medial groove at its summit into 2 longitudinal ridges. Rear portion of dorsal shield missing. Branchial regions divided into 2 parts by branchial cardiac furrows running forward and outward; anterior region has single longitudinally expanded granule near outer edge, posterior branchial region has 2 granules on outer margin directly behind 1 on the anterior branchial lobe. The anterior of these 2 is longitudinally expanded and large; the posterior round and small.

Margins of dorsal shield poorly preserved. The photograph, taken before preparation was finished, gives the impression of a straight lateral margin (left side) nearly to a point on line with the rear of the orbits. The right side appears to be gently convex.

Comparison. — *Dioratiopus scotti* is most similar to *D. spinosa* (Van Straelen 1936) in the size and shape of carapace regions. It differs from *D. spinosa* by having a wider urogastric region with 2 transverse ridges, a longitudinally bilobate cardiac region, apparently no furrow delimiting an epigastric region, distal spines on the branchial regions, and probably a smoother carapace. The differences in carapace size and shape, size, shape, and arrangement of carapace regions, and ornamentation is even greater between *D. scotti* and other congeners.

Remarks. — The placement of this single specimen into generic level taxon is strongly hampered by its mode of preservation as a steinkern and by the obscure nature of the lateral margins of the carapace fragment. The discontinuous nature of the lateral margins may point to the lack of dorsal pleural sutures, *linea homolica*, in which case this specimen does not belong in *Homolopsis*. This lack of a straight break and the similarity of carapace morphology to *Dioratiopus* suggests a close alliance with this genus, and the specimen is therefore assigned to *Dioratiopus* until more complete material becomes available.

Section Oxystomata H. Milne-Edwards 1834

Superfamily Calappoidea de Haan 1833

Family Calappidae de Haan 1833

Subfamily Necrocarcininae Förster 1968

Genus *Pseudonecrocarcinus* Förster 1968

Type species. — By monotypy; *Necrocarcinus quadrisissus* Noetling 1881, p. 368, pl. 20, fig. 4); Maastrichtian, Limbourg, Holland.

Diagnosis. — Carapace wider than long, frontal-orbital margin about $\frac{1}{2}$ carapace width. Medial regions poorly differentiated. Mesogastric and protogastric regions combined into wing-like swellings. Inner side of epibranchial region with ridge, outer side with tubercle groups; metabranchial region with weak longitudinal ridges. Sulcus of rostrum with 2 or 4 pits. Deeply incised angular grooves form the lateral boundaries of the urogastric region.

Pseudonecrocarcinus stenzeli new species

Pl. 1, figs. 3–5; Fig. 8B

Types.—The Holotype, an impression of a carapace, (orig. GAB 25, specimen 8) is deposited in the San Diego Natural History Museum (SDSNH 23641).

Occurrence, sample size, and preservation.—The Holotype, an impression, and 5 partial carapaces were collected at GAB 25.

Etymology.—Named in honor of Dr. Henryk B. Stenzel, a leader in the study of Cretaceous and Tertiary Texas decapods.

Description.—Carapace slightly wider than long; widest about $\frac{1}{3}$ distance from front. Length from broken tip of rostrum to hind margin 11.8 mm and width (computed as 2 times the width of half the crab) 12.5 mm.

Carapace fairly flat transversely and longitudinally, anterolateral margins lie lower than gastric arch. Cervical furrow broad, faint distally but narrower and more distinct on central part of carapace near where it ends in a pair of gastric pits; branching at distal end, 1 branch continues laterally to dorsal shield edge and other swings anteriorly forming a broad, shallow depression which borders anterior side of hepatic region, arched orbital region, and arched protogastric region. Epimeral muscle scars deep, forming the most noticeable grooves. Inner side of V's thus formed continue forward as shallow, broad depressions connecting with cervical furrow; very faint grooves separate mesogastric and protogastric regions.

Carapace regions poorly differentiated by shallow grooves; separation into bosses or areoles similarly subdued. Rostrum broad, nearly 25% carapace width. Orbits large, arched upward, 2 fissures on rear margins, width between outer edges of orbits about 50% carapace width. Mesogastric and protogastric regions barely discernable. Two pairs of pits lie behind rostrum in mesogastric–protogastric grooves on line with back of supraorbital fissures; outermost pair larger, situated slightly more forward than smaller, better-defined pair. Protogastric regions with broad, poorly defined bosses. Hepatic region with raised boss directly above anterolateral spine. Cardiac regions sharply set off from branchial regions by epimeral muscle scar but barely separated anteriorly except for shallow cervical groove, continuing posteriorly with intestinal regions to hind margin. Branchial regions broadly arched near epimeral muscle scars, with a raised ridge along carapace edge from just behind cervical furrow to a point on line with middle part of epimeral muscle scar.

Anterolateral margin slightly concave for a short distance as it leaves protruding outer edge of orbit, dropping in elevation until it begins to become convex, arching slightly upward then downward just in front of hepatic spines. Indentations in carapace margin in front of hepatic spine and behind it where cervical furrow meets carapace edge. Posterolateral margin slightly convex from cervical furrow to hind margin. Hind margin concave, bordered by shallow but distinct groove.

Carapace ornamentation consists of the few broad bosses, anterodistal branchial ridges, deep epimeral muscle scar, shallow grooves, and a very fine granulation (slightly coarser on medial part) over carapace.

Comparison.—The genus *Pseudonecrocarcinus* contains *P. quadriscissus* (Noetling 1881), *P. biscissus* Wright and Collins 1972, and *P. stenzeli* Bishop new species. All 3 species have post-rostral pits in common. This character separates this genus from the other genera of the Necrocarcininae. In *Pseudonecrocarcinus stenzeli* and *P. quadriscissus* the pits are elongated into slits. The carapace of *P. stenzeli* is much smoother than that of *P. quadriscissus*.

Remarks.—The presence of pits at the base of the rostrum unite *P. quadriscissus*, *P. biscissus*, and *P. stenzeli* into a distinct group. I believe it is best to maintain their distinction as a separate genus until such time as we have more data with which to judge the phylogenetic affinities of the necrocarcinids.

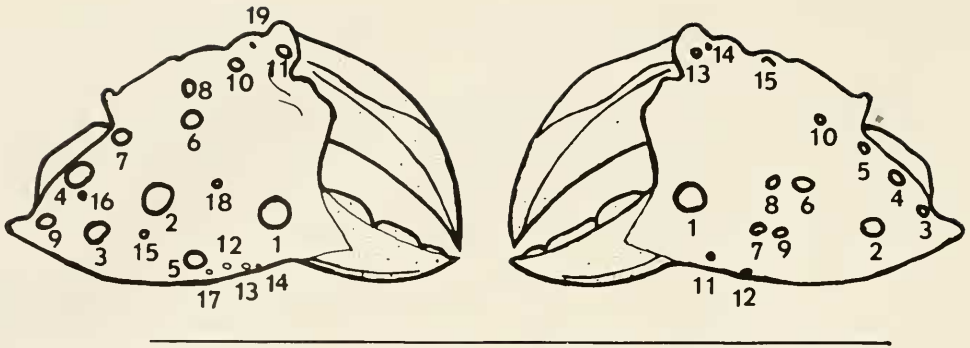


FIGURE 11. Tubercle placement on claws of *Prehepatus hodgesi* Bishop.

Superfamily Calappoidea de Haan 1833
 Family Calappidae de Haan 1833
 Subfamily Matutinae McLeay 1838
 Genus *Prehepatus* Rathbun 1935

Type species.—By original designation: *Prehepatus cretaceous* Rathbun 1935, p. 47, Pl. 11, figs. 29–30.

Diagnosis.—Chelae small, increasing in height to distal end of palm; fixed finger short, movable finger stout; transversely flat to concave on inner face, convex on outer face with upper margin broadly rounded to flat and forming an oblique keel which overhangs the inner face; surface ornamented by strong tubercles.

Prehepatus hodgesi new species

Pl. 3, figs. 1–19; Figs. 8F, 11, 12; Tab. 7

Types.—The holotype of *Prehepatus hodgesi* is a partial right propodus (orig. GAB 25, specimen 14) deposited in the San Diego Natural History Museum (SDSNH 23655). Six paratypes (SDSNH 23656 to 23661) are also deposited in the San Diego Natural History Museum.

Occurrence, sample size, and preservation.—Twenty claws of this taxon are known from localities GAB 21, GAB 25, and GAB 26.

Etymology.—Named in honor of Floyd Hodges whose fortuitous spilling of coffee on his lap caused the discovery of the Boerne-Sisterdale locality (GAB 25) which yielded so many fine specimens of this taxon.

Description.—Carpus with large tubercle on rear distal corner, smaller tubercle on front distal corner, 1 on center of dorsal face and 1 midway on rear dorsal margin. Margin of proximal, dorsal side with row of 5 granules.

Right propodus triangular, about twice as long as high (Table 7), palms slightly longer than high, highest at distal end of palm. Level upper margin about half the length of convex lower margin, flat, horizontally overhanging inner face at proximal edge. Carinate proximal part of crest gives way to 4 broad, thin blade-like spines which become progressively more vertical distally to base of dactylus. Lower margin transversely convex. Outer face convex longitudinally, very convex transversely. Inner face fairly flat. Two broad, shallow concavities present, 1 below upper margin and 1 at proximal end just above lower margin. Propodus ornamented by numerous tubercles (situated in 3 lines). Upper sinuous row of 6 tubercles (9, 7, 8, 10, 11) beginning at lower carpal articulator follows the carpal margin, swinging forward to follow the upper margin to distal edge above dactyl articulator. Second row begins at same point as first (near lower carpal articulator), proceeds in sinuous path to base of fixed finger through 4 large tubercles (counting the first one again) (9, 3, 2, 1) and 1 minor tubercle (18) between distal 2 tubercles (1 and 2). The distal 3 tubercles of this row are the most

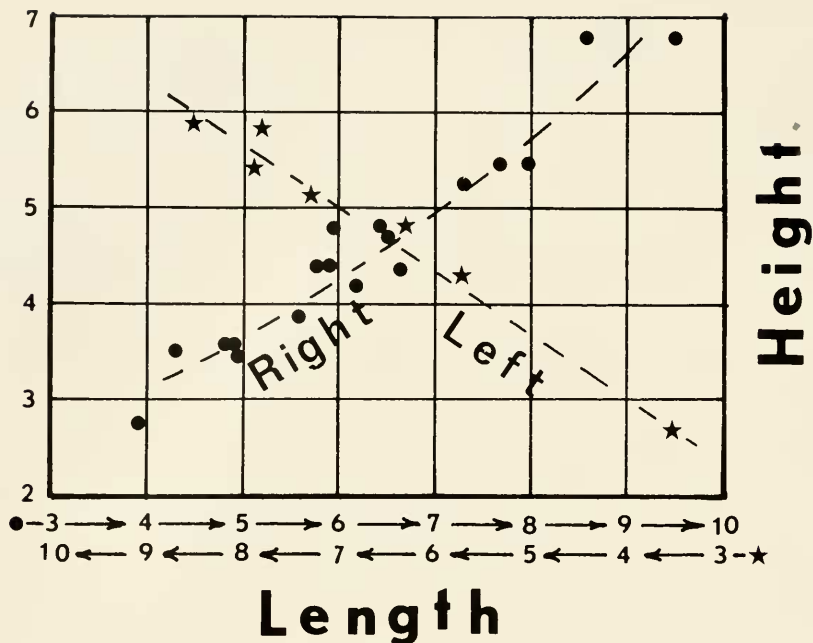


FIGURE 12. Graph of palm height (mm) vs. palm length (mm) for *Prehepatus hodgesi* Bishop. Right claws plotted as dots (read length on top scale increasing left to right) and left claws as stars (read length on lower scale increasing from right to left).

consistent of the tubercles in presence and relative size. A third row of tubercles (5, 12, 13, 14) runs in a straight line from a medium tubercle (5) above midpoint of lower margin almost to lower edge of the fixed finger. In addition to these "rows" a small node is sometimes found in angle formed by the upper rows (16), a medium tubercle (6) below middle of upper row, a small one (15) below and behind tubercle 2, a small one (17) below tubercle 5, and a small one (19) above and between tubercles 10 and 11. A spot above tubercle 8 sometimes is roughened or tuberculate. Inner face ornamented by a single tubercle midway along carpal margin. Fixed finger turned downward and slightly inward, with faint furrow on lower edge of outer face. At least 2 "teeth" are present on prehensile edge; proximal tooth's surface divided into 3 lobes. Movable finger strongly curved, with narrow angular ridge on outer side from the articulator to midway along dactyl, where it broadens and rounds out to tip. Fingers finely granulate and weathered differently than rest of claw, appearing more stable or resistant.

Left propodus same shape as right, probably also same size (Table 7), outer surface with fewer tubercles than right. Tubercle size highly variable, positions more variable than those on right claw. A row of 4 tubercles (3, 4, 5, 10) runs in an arc along carpal margin from lower articular onto palm. Most other tubercles lie on 2 lines that run between major tubercle (1) at base of fixed finger to a large spine (2) distal of lower carpal articulator, upper row convex upwards, consisting of 4 tubercles (1, 8, 6, and 2), lower row convex downward and consisting of 4 tubercles (1, 7, 9 and 2). Two small tubercles (11 and 12) may be situated on lower edge of palm below tubercles 1 and 7. Three small tubercles (13, 14, and 15) may be present on flattened crest.

Comparison.—*Prehepatus hodgesi* has a consistent (though variable) pattern of tuberculation different than *P. cretaceus* Rathbun 1935; *P. pawpawensis* Rathbun 1935; and *P. dilksi* Roberts 1962. *Prehepatus hodgesi* is not as rectangular as *P. cretaceus* Rathbun 1935, lacks the great number of spines on the upper margin, does not possess the large tubercle near the upper dactyl articulator, and does not have a tuberculate dactylus.

Prehepatus hodgesi does not have the numerous fine granules of *P. pawpawensis*.

TABLE 8. Measurements in millimeters of claws of *Torynomma? densus*.

Specimen	Palm length (mm)	Height (mm)	Claw length (mm)	Claw thickness (mm)
SDNHM 23664 (=25-5)	7.5	7.0	12.3	3.8
SDNHM 23663 (=25-10)	7.2	5.8		

Prehepatus hodgesi differs from *P. dilksi* Roberts 1962 in its ornamentation, lack of granulate dactylus, and lack of the vertical furrow and rim on the propodus along the distal end of the outer surface.

Remarks.—The taxon shows a surprisingly consistent pattern of ornamentation in the arrangement of tubercles and an equally surprising amount of variation in size (or presence) of the tubercles. If only a few specimens had been found, it is quite probable I would have been tempted to place them in different species level taxa.

I feel fairly confident that there are at least 2 recognizable instars. The smaller specimens are relatively thinner and nearly smooth. A second instar shows tremendous variation in tubercle size. A third possible instar may be present and contains the largest, most-ornamented specimens.

The data on cheliped ornamentation are included as I believe there may be a behavioral analogy with the claws of fiddler crabs (Crane 1975) and the data may be useful to subsequent decapod workers.

Section Brachyrhyncha Borradaile 1907
 Superfamily Dorippoidea de Haan 1841
 Family Dorippidae de Haan 1841
 Genus *Torynomma* Woods 1953

Type species.—*Torynomma quadrata* by original designation.

Diagnosis.—“Carapace subquadrate, widest anteriorly, orbital grooves large, rostrum narrow, oviduct opening on coxa of 3rd pereopods.” (Glaessner 1969:493.)

Torynomma? densus new species
 Pl. 3, fig. 32–40; Fig. 8J; Tab. 8

Types.—The Holotype, a right propodus (GAB 25, specimen 5) and paratype (GAB 25, specimen 10) are deposited in the San Diego Natural History Museum (SDSNH 23664 and SDSNH 23663 respectively).

Occurrence, sample size, and preservation.—*Torynomma? densus* is represented by 2 right propodi from GAB 25. The holotype is nearly complete except for some dissolution of exoskeleton. The paratype is partly crushed on the inner side and has the fixed finger broken off. Neither specimen preserves the dactylus. The band of dense exoskeleton along the distal margin and on the fixed finger is excellently preserved on each specimen.

Etymology.—For dense exoskeleton along distal edge of claw.

Description.—Claw nearly twice as long as high, palm slightly longer than high. Lower margin slightly convex, tightly rounded at lower proximal corner slanting forward along carpal articulation, then broadly rounded to convex upper margin. Distal edge nearly vertical concave to base of fixed finger. Fixed finger long, narrow, curving inward; decreasing in size distally by 2 steps before it reaches pointed tip. Outer face of claw convex, inner face slightly convex. A band of dense exoskeleton present along distal edge of claw and on fixed finger.

Shallow depression on outer face on dense band at base of upper margin of fixed finger, giving way to shallow groove that parallels lower margin of finger to its tip. Field of small granules near the upper part of dense band and below fixed finger groove. A smooth lineation lies on the lower edge of the claw giving rise to an apparent groove. Knob-shaped upper carpal articulator granulate.

Inner face fairly flat, shallow depression below upper margin forming slight overhanging ridge, coarsely granulate on dense band. A shallow, smooth groove running along middle of finger joins second step-down. Dense band abundantly granulate below groove and sparsely granulate above it. A field of numerous granules lies on the dense band even with upper margin of fixed finger. Occlusional surface formed by a broad edge with 2 "teeth" formed where the step-downs in size occur.

Comparison.—*Torynomma? densus* has a shape similar to *Torynomma quadrata* Woods 1953 but differs by a more convex lower margin, a stouter, stepped-down fixed finger, and the band of very dense exoskeleton on the fixed finger and along the distal edge of the palm.

Remarks.—The assignment of this claw to a taxon was most difficult because most taxa that have a preserved carapace do not have an adequate description of the chelae. The dense exoskeleton on the finger and distal edge of the claw suggests that this may be a xanthid-like crab. It was not assigned to the Xanthidae because on xanthids usually only the fingers have dense exoskeleton, the fixed finger in xanthids normally has "teeth," and this taxon would have extended the range of xanthids from Upper Cretaceous into the Lower Cretaceous.

It was deemed better in this case to name a new taxon (knowing it will most likely be synonymized when the claw is matched to a carapace) than to have yet another nameless taxon to refer to in the literature.

ACKNOWLEDGMENTS

Many persons were directly or indirectly involved in this study. Those who aided by helping collect specimens were Nelda Bishop, Susan Deutsch Conger, Arthur Cleaves, Lyman Dawe, Tom Grimshaw, Floyd Hodges, Don Lentzen, John Newcomb, Mary Beth Bowers Schwartz, and Keith Young. Discussions with Keith Young, H. B. Roberts, Alan Scott, and particularly Peter Rodda resulted in a stimulus to complete this study. The manuscript was reviewed by Rodney Feldmann and Karl Waage. Jacque Causey typed the final manuscript at Georgia Southern College. A Faculty Research Grant from the Faculty Research Committee, Georgia Southern College, expedited the completion of this work, and an NSF grant (DEB 8011570) provided time for major revision and publication costs.

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